

PATENT APPLICATION

of

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for a

METHOD AND APPARATUS FOR USE BY A GPRS DEVICE IN  
RESPONDING TO CHANGE IN SAPI CONNECTION

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# METHOD AND APPARATUS FOR USE BY A GPRS DEVICE IN RESPONDING TO CHANGE IN SAPI CONNECTION

## TECHNICAL FIELD

The present invention pertains to the field of General  
5 Packet Radio Service (GPRS). More particularly, the present  
invention pertains to a change in a SAPI (Service Application  
Point Identifier) connection in a GPRS device, such as a GPRS-  
enabled cellular telephone.

## BACKGROUND ART

### *General*

As shown in Fig. 1, according to 3G WCDMA (Third  
Generation Wideband Code Division Multiple Access), in  
communicating via wireless communication a mobile user  
equipment (UE) 18 interfaces with an UTRAN (universal mobile  
15 telecommunications system (UMTS) terrestrial radio access  
network) 17, and in particular with a Node B 17a (also  
sometimes called a base station) of the UTRAN 17, over a so-  
called Uu interface, which can be provide a circuit-switched  
(CS) or packet-switched (PS) connection between the UE and the  
20 UTRAN. The UTRAN Node B in turn communicates with an UTRAN  
radio network controller (RNC) 17b over a so-called Iub  
interface, and the RNC communicates with a core network (CN)  
entity 19, either a mobile switching center (MSC) or a serving  
GPRS (general packet radio system) support node (SGSN) 19a,  
25 over a so-called Iu interface, and also communicates with  
other RNCs over a so-called Iur interface. The Iu interface is  
more specifically either a Iu circuit-switched interface IuCS  
between an UTRAN RNC and an MSC, or a Iu packet-switched  
interface IuPS between an UTRAN RNC and a SGSN.

30 A corresponding architecture exists in the case of GSM  
(Global System for Mobile Communications) providing a GSM RAN  
21, in which case the UE/RAN interface is called the Um

interface, which thus can provide either a CS connection or a PS connection, and it is GPRS that provides the latter. Fig. 2 shows the logical architecture of GPRS in case of a GSM implementation. In case of GSM, the UE interfaces (over the Um interface) with a Base Station System (BSS) 21a of the GSM RAN 21, which in turn interfaces with a SGSN 22a of a GSM core network 22.

GPRS is thus the service offered by the core network by which a UE is provided a PS connection to another device, via the UTRAN or GSM RAN, for communicating with the other device (such as a device connected to the Internet or just another UE) by the exchange of packets. The overall GPRS logical architecture is defined in 3GPP TS 03.60.

In the PS domain, packet connections are called sessions and they are established and managed by an entity called Session Management (SM). SM is a logical entity having two states, inactive and active. In the inactive state, packet data transfer is not possible and routing information (if it exists) is not valid. In the active state, packet data transfer is possible and all valid routing information is present and defined. The protocol used for packet data transfer during an active session is called Packet Data Protocol (PDP). Many different PDPs are possible, including Internet Protocol (IP) (various versions) and X.25.

The SM handles packet session attributes as so-called contexts, i.e. PDP contexts. A PDP context contains all parameters describing a packet data connection, i.e. a connection between two end point addresses and having a prescribed quality of service (QoS). For example, a PDP context holds information such as allocated IP addresses, connection types and related network element addresses. From the service point of view, one PDP context is set up for one packet switch service with a prescribed QoS class. Thus, for

example, web surfing and streaming video over a packet connection each have their own PDP context. (In UMTS, per 3GPP R99, QoS classes include: conversational class, streaming class, interactive class and background class.)

5           The activation of a PDP context causes the SM to change its state from inactive to active. When a PDP context is activated, a UE and the network are able to establish a bearer for data transfer. When the SM is active (and so when a PDP context exists), the existing PDP context can be changed. To  
10          change a PDP context, the UE and the network renegotiate packet session characteristics.

          Network layer protocols are intended to be capable of operating over services derived from a wide variety of subnetworks and data links. GPRS supports several network  
15          layer protocols providing protocol transparency for the users of the service. Introduction of new network layer protocols to be transferred over GPRS is intended to be possible without any changes to GPRS. Therefore, all functions related to transfer of Network layer Protocol Data Units (N-PDUs)  
20          (including control data and possibly user data) are intended to be carried out in a transparent way by GPRS network entities. When GPRS is used over GSM RAN, it is a function of the so-called GPRS SNDCP (subnetwork dependent convergence protocol) layer, a protocol layer using the services of the  
25          logical link (protocol) layer (LLC) as shown in Fig. 3, to provide such transparency. Another function of SNDCP is to improve channel efficiency. This requirement is fulfilled using compression techniques.

          As shown in Fig. 4, the protocol entities above SNDCP  
30          (i.e. using the services of SNDCP) are various commonly used network protocols, or more particularly packet data protocols (such as IPv4 and IPv6). A SNDCP entity performs multiplexing of data coming from different PDPs for transmission using (the

service provided by) the LLC layer. The Network Service Access Point Identifier (NSAPI) is an index to the PDP context of the PDP that is using the services provided by SNDCP (a service access point being a conceptual point where a protocol layer offers to an upper protocol layer access to its services). One PDP may have several PDP contexts and NSAPIs. However, it is possible that each allocated NSAPI is used by a different PDP. Each active NSAPI is required to use the services provided by the Service Access Point Identifier (SAPI) in the LLC layer. Several NSAPIs may be associated with the same SAPI.

Fig. 5 illustrates the service access points through which service primitives used for communication between the SNDCP layer and other layers are carried out. The primitives provided by the SNDCP layer (to PDPs) are listed in Table 1.

**Table 1: SNDCP layer service primitives.**

Generic Name	Type				Parameters
	Request	Indication	Response	Confirm	
SNDCP User (PDP or the SGSN Relay) ↔ SNDCP					
SN-XID	X	X	-	-	Requested SNDCP XID Parameters
SN-XID	-	-	X	X	Negotiated SNDCP XID Parameters

For example: a SN-XID REQUEST primitive is a request used by the SNDCP user at the initiating entity to deliver the list of requested XID parameters to the peer entity; a SN-XID INDICATION is an indication used by the SNDCP entity to deliver the list of requested XID parameters to the SNDCP user; a SN-XID RESPONSE is a response used by the SNDCP user to deliver the list of negotiated XID parameters to the peer entity; and a SN-XID CONFIRM is a confirmation used by the SNDCP entity to deliver the list of negotiated XID parameters to the SNDCP user.

The SNDCP layer uses the service primitives provided by the SM sublayer and the LLC layer shown in Table 2. SM is specified in 3GPP TS 04.08 and LLC in 3GPP TS 04.64.

Table 2: Service primitives used by the SNDCP entity.

Generic Name	Type				Parameters
	Requ st	Indication	Response	Confirm	
SNDCP ↔ LLC					
LL-RESET	-	X	-	-	TLLI
LL-ESTABLISH	X	-	-	-	TLLI, XID Requested
LL-ESTABLISH	-	X	-	-	TLLI, XID Requested, N201-I, N201-U
LL-ESTABLISH	-	-	X	-	TLLI, XID Negotiated
LL-ESTABLISH	-	-	-	X	TLLI, XID Negotiated, N201-I, N201-U
LL-RELEASE	X	-	-	-	TLLI, Local
LL-RELEASE	-	X	-	-	TLLI, Cause
LL-RELEASE			-	X	TLLI
LL-XID	X	-	-	-	TLLI, XID Requested
LL-XID	-	X	-	-	TLLI, XID Requested, N201-I, N201-U
LL-XID	-	-	X	-	TLLI, XID Negotiated
LL-XID	-	-	-	X	TLLI, XID Negotiated, N201-I, N201-U
SNDCP ↔ SM					
SNSM-ACTIVATE		X	-	-	TLLI, NSAPI, QoS profile, SAPI, Radio Priority
SNSM-ACTIVATE	-	-	X		TLLI, NSAPI
SNSM-DEACTIVATE	-	X	-	-	TLLI, NSAPI(s), LLC Release Indicator
SNSM-DEACTIVATE	-	-	X	-	TLLI, NSAPI
SNSM-MODIFY	-	X	-	-	TLLI, NSAPI, QoS Profile, SAPI, Radio Priority, Send N-PDU Number, Receive N-PDU Number
SNSM-MODIFY	-	-	X	-	TLLI, NSAPI

For example: a LL-XID REQUEST (primitive) is a request used by the SNDCP layer to deliver the requested SNDCP XID parameters to the LLC layer; a LL-XID INDICATION is an indication used by the LLC layer to deliver the requested SNDCP XID parameters to the SNDCP layer; a LL-XID RESPONSE is a response used by the SNDCP layer to deliver the negotiated SNDCP XID parameters to the LLC layer; and a LL-XID CONFIRM is a confirmation used by the LLC layer to deliver the negotiated SNDCP XID parameters to the SNDCP layer.

Also, and more importantly for the present invention, a SNSM-MODIFY INDICATION is an indication used by the SM entity to trigger change of the QoS profile (see 3GPP TS 04.08) for a NSAPI and an indication of the SAPI to be used. It is also used by the SM entity in the SGSN to inform the SNDCP entity that a NSAPI is to be created, together with the (re-)negotiated QoS profile, the SAPI assigned, and, in the

MS, the radio priority level to be used by RLC (radio link control)/MAC (media access control). A SNSM-MODIFY RESPONSE is a response used by the SNDSCP entity to inform the SM entity that the indicated NSAPI and QoS profile are now in use and the acknowledged peer-to-peer LLC operations for the appropriate SAPIs are established and/or released, if necessary.

*Problem(s) addressed by the invention*

As indicated above, the GPRS protocol architecture consists of various protocol layers. The operation of each layer is specified in detail in corresponding documents, however, the cooperation of these layers is not yet well specified. One problem is the cooperation between the SNDC layer and the LLC. As indicated above, SNDC handles PDP contexts and each context has a NSAPI number; there can be up to eleven parallel PDP contexts. LLC handles logical links, and each logical link has its own SAPI number; there can be up to four parallel logical links. As mentioned, one NSAPI can be mapped to only one SAPI at any one time, i.e. one NSAPI corresponds to only one NSAPI, but several NSAPIs can be mapped to the same SAPI, i.e. one SAPI may correspond to several NSAPIs. The network controls the mapping between contexts of SAPIs and NSAPIs and it is possible for the network to change the mapping on the fly. PDP contexts having different QoS profiles must be placed in separate SAPIs. SNDC level compression algorithms are negotiated using LLC level procedures (using so-called XID negotiation).

3GPP LLC specification 04.64 says that LLC messages received on a SAPI not mapped to a PDP context can be discarded. However, SNDC specification (04.65) says that after a context modification procedure, the network should in certain cases start XID (context identifier) negotiation and/or a logical link disconnection procedure using the old

SAPI. This causes a conflicting situation, i.e. the network sends LLC messages that the mobile side is allowed to discard. Depending on the network implementation, this can cause a long break in the data transfer or even PDP context deactivation.

5           The easiest solution is to keep all LLC links active at all times. However, this has a negative memory consumption effect since the data structures need to be reserved for all SAPIs. Another solution is to not really support four parallel independent LLC links. This solution is fine if you support  
10 one PDP context only, or if the network always maps all NSAPIs to one SAPI, but it does not work when you have several contexts that need separate SAPIs (because of different QoS). A third alternative is to allow mapping of one NSAPI to two SAPIs until LLC link disconnection procedure and/or XID  
15 negotiation for the old SAPI has taken place. However, it is possible that the network does not perform the link disconnection procedure or XID negotiation at all, and in that case the old SAPI would be left active.

          What is needed is a procedure (protocol) according to  
20 which in case of a mobile receiving a PDP context modification message, the mobile does not discard at least some of the LLC messages sent by the network, at least not for a time deemed long enough that no significant break in data transfer is likely, nor is PDP context deactivation.

#### 25   DISCLOSURE OF THE INVENTION

          Accordingly, in a first aspect of the invention, a method is provided for use by a user equipment (UE) device enabled for communication with other telecommunication devices via a network including a radio access network and providing general  
30 packet radio service (GPRS), the method for use by the UE device in responding to a message from the network indicating a change in a service access point identifier (SAPI) connection from an old SAPI to a new SAPI, the method



characterized by: a step, responsive to an indication from the network of a change from the old SAPI to the new SAPI, of setting a timer for a period of time; and a step of terminating the old SAPI.

5           In accord with the first aspect of the invention, in the step of terminating the old SAPI, the old SAPI may not terminate until after the period of time expires, and the period of time may be predetermined to be long enough for the network to send to the new SAPI a message providing  
10           compressions for the new SAPI.

          Also in accord with the first aspect of the invention, the timer period may be set to approximately 15 seconds.

          In a second aspect of the invention, a computer program product is provided comprising: a computer readable storage  
15           structure embodying computer program code thereon for execution by a computer processor in a UE device, with said computer program code characterized in that it includes instructions for performing the steps of the method according to the first aspect of the invention.

20           In a third aspect of the invention, a telecommunication device is provided enabled for communication with other telecommunication devices via a network including a radio access network and providing general packet radio service (GPRS), the telecommunication device adapted for responding to  
25           a message from the network indicating a change in a service access point identifier (SAPI) connection from an old SAPI to a new SAPI, the telecommunication device characterized by: means, responsive to an indication from the network of a change from the old SAPI to the new SAPI, for setting a timer  
30           for a period of time; and means for terminating the old SAPI.

          In accord with the third aspect of the invention, the means for terminating the old SAPI may be so adapted that the old SAPI is not terminated until after the period of time

expires, with the period of time predetermined to be long enough for the network to send to the new SAPI a message providing compressions for the new SAPI.

5 In a fourth aspect of the invention, a telecommunication system is provided comprising a telecommunication device and a network including a radio access network and providing GPRS, wherein the telecommunication device is as provided by the third aspect of the invention.

10 In a fifth aspect of the invention, a method is provided for use by a telecommunication network in communicating with a user equipment (UE) device enabled for communication with other telecommunication devices, the network including a radio access network and providing general packet radio service (GPRS), the method for use in indicating to the UE device a  
15 change in a service access point identifier (SAPI) connection from an old SAPI to a new SAPI, the method including: a step of providing to the UE device a request to change to the new SAPI; a step of removing compressions from the old SAPI; and a step of providing compressions for the new SAPI; the method  
20 characterized by the network continuing to provide messages for the old SAPI after providing to the UE device the request to change to the new SAPI and also providing messages for the new SAPI.

25 In a sixth aspect of the invention, a telecommunication network is provided adapted for communicating with a user equipment (UE) device, the network including a radio access network and providing general packet radio service (GPRS), the telecommunication network adapted for indicating to the UE device a change in a service access point identifier (SAPI)  
30 connection from an old SAPI to a new SAPI, the telecommunication network including: means for providing to the UE device a request to change to the new SAPI; means for removing compressions from the old SAPI; and means for

providing compressions for the new SAPI; the telecommunication network characterized by the network continuing to provide messages for the old SAPI after providing to the UE device the request to change to the new SAPI and also providing messages for the new SAPI.

In a seventh aspect of the invention, a system is provided comprising a UE device and a telecommunication network including a radio access network and providing GPRS, wherein the telecommunication network is according to the sixth aspect of the invention.

Thus, according to the invention, when the mobile receives a PDP context modification message from the network indicating that a NSAPI that was mapped to an old SAPI is now to be mapped to a new SAPI, the mobile starts a timer to expire after some timer period. During the timer period, the old LLC SAPI is kept alive and all messages received on the old SAPI are handled, and messages received on the new SAPI are also handled; thus, during the timer period, the mobile has two SAPIs active. When the timer period expires, the old SAPI is deleted, and after that all messages received on the old SAPI are discarded.

The invention is advantageous in that it uses relatively little of the memory resources of a mobile, and also in that it guarantees compatibility with different network implementations.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the invention will become apparent from a consideration of the subsequent detailed description presented in connection with accompanying drawings, in which:

Fig. 1 is a block diagram/ flow diagram of an UMTS telecommunication system providing GPRS, according to the

prior art.

Fig. 2 is a block diagram/ flow diagram of a GSM telecommunication system providing GPRS, according to the prior art.

5 Fig. 3 is a schematic of the GPRS protocol stack, including an SNDCP layer and a LLC layer.

Fig. 4 is a schematic illustrating SNDCP multiplexing of different protocols.

10 Fig. 5 is a schematic illustrating the service access points through which service primitives used for communication between the SNDCP layer and other layers are carried out.

Fig. 6 is a message sequence diagram according to the invention.

#### BEST MODE FOR CARRYING OUT THE INVENTION

15 Referring now to Figs. 1, 2, and 6, the invention provides a method for use by a telecommunication device 18-- i.e. a so-called user equipment (UE) device--enabled for communication with other telecommunication devices (not shown) via a telecommunication network including a core network 19, 22 and a radio access network (RAN) 17 21 and adapted to  
20 provide GPRS (General Packet Radio Service), the method for use in responding to a message from the network (either originating in the core network 19, 22 or in the RAN 17 21, but provided by the RAN 17 21) indicating a change in a SAPI  
25 (service access point identifier) connection from an old SAPI to a new SAPI, the method including steps 20e 20r that provide for keeping the old SAPI active for a period of time during which the device 18 handles messages received on the old SAPI as well as messages received on the new SAPI.

30 Referring now especially to Fig. 6, operation according to the invention of the UE device 18 (Fig. 1) is shown as

including a first step 60a in which the UE device--and more specifically, the session management (SM) entity of the UE device--receives from the RAN 17 21 a PDP CONTEXT MODIFY REQUEST corresponding to a change to the PDP context made by the network (either the RAN or the core network 19 22). The change provides a new QoS and a new logical link layer (LLC) SAPI (Fig. 4); more specifically, the change in SAPI is from an old SAPI, indicated as (LLC) SAPI-A, to a new SAPI, indicated as (LLC) SAPI-B. In a next step 60b, assuming here that the UE device agrees to the change, the SM of the UE device sends to the network a PDP CONTEXT MODIFY ACCEPT message, and then, in a next step 60c, sends to the SNDCP (subnetwork dependent convergence protocol) layer (Figs. 3-5) of the UE device a so-called SNSM MODIFY INDICATION message indicating the new QoS and SAPI. In a next step 60d, the SNDC (i.e. the SNDCP layer) activates the new (LLC) SAPI (SAPI-B) and also, in a next step 60e, starts a timer. A timer period of approximately 15 seconds is typical; it is long enough for a new SAPI to be fully activated, i.e. it is long enough for the UE device to receive from the network a message providing compressions for the new SAPI.

At this point, both the old SAPI (SAPI-A) and the new SAPI (SAPI-B) are active. Now, in a next step 60f, the network sends a XID REQUEST message to SAPI-A, thus initiating XID negotiation to remove compressions for the old SAPI (SAPI-A). (SNDC XID negotiation is piggy-backed in LLC XID messages, which is why in Fig. 6 the parenthetical annotation SNDC XID is included with message 60f as well as each subsequent XID-related message. Of course a LLC XID message can also include the LLC's own parameters, but as these are not relevant for understanding the invention, they are not shown in Fig. 6.)

Upon receipt of the XID REQUEST, in a next step 60g SAPI-A sends a so-called LL XID INDICATION message to the SNDC. In a next step 60h, SNDC sends to SAPI-A a LL XID RESPONSE

(acknowledging the LL XID INDICATION), and in a next step 60j, SAPI-A forwards the acknowledgment on to the network as a XID RESPONSE message.

Now, instead of terminating the old SAPI (SAPI-A) at this point in the change procedure, according to the invention the UE device handles messages to both the old SAPI (SAPI-A) and the new SAPI (SAPI-B) until the timer expires. Thus, during this time, the network continues to provide messages for the old SAPI and also provides messages for the new SAPI.

Soon after receiving the forwarded XID RESPONSE message from the old SAPI (SAPI-A), the network sends a XID REQUEST to the new SAPI (SAPI-B) in a next step 60k, thus providing compressions for the new SAPI. Then, in a next step 60m, the new SAPI sends a LL CID INDICATION message to SNDC, which in a next step 60n responds to the new SAPI with LL XID RESPONSE acknowledging the message. In a next step 60p, the new SAPI forwards the XID RESPONSE to the network. Finally, in a next step 60q, after the timer expires, the SNDC terminates the old SAPI by sending it a LL SLEEP REQUEST.

The invention uses a timer to avoid losing messages instead of relying on handshaking with the new SAPI, i.e. instead of having the SNDC, once aware that a new SAPI is being created, periodically interrogate the new SAPI to determine when the new SAPI is ready to receive messages. Handshaking cannot be relied on because XID negotiation on the new SAPI is optional: if the network does not want to use compressions, it does not have to send a XID at all. In such an instance, the new LLC SAPI is ready for data transmission immediately after step 60c (in which SNDC receives an SNSM MODIFY INDICATION) and the timer of the invention is not needed, but of course can still be used without causing a problem. If XID negotiation (or some other handshaking) were mandatory before data transmission over a LLC SAPI,

handshaking could be used instead of a timer.

It is to be understood that the above-described arrangements are only illustrative of the application of the principles of the present invention. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the scope of the present invention, and the appended claims are intended to cover such modifications and arrangements.